



G A O

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**United States General Accounting Office
Washington, DC 20548**

September 5, 2001

The Honorable Dana Rohrabacher
Chairman, Subcommittee on Space
and Aeronautics
Committee on Science
House of Representatives

The Honorable Bart Gordon
Ranking Minority Member, Subcommittee
on Space and Aeronautics
Committee on Science
House of Representatives

Subject: Survey of NASA's Lessons Learned Process

You asked us to assess whether the National Aeronautics and Space Administration (NASA) has adequate mechanisms in place to ensure that past lessons learned from mission failures are being applied. As part of your request, you asked that we provide the results of our survey regarding the collection and sharing of lessons learned by NASA program and project managers. This letter provides the results. We plan to issue a more detailed report on the effectiveness of NASA's lessons learned process early next calendar year.

As part of our assessment of NASA's effectiveness in applying lessons learned, we surveyed all of NASA's program and project managers to obtain their perspectives on (1) the collection, access, and use of lessons learned, (2) the strengths and limitations of current NASA's lessons learned processes, procedures, and systems, including the Lessons Learned Information System (LLIS), (3) the challenges or barriers to the sharing of lessons learned, and (4) suggested areas of improvement. This represented 192 managers overseeing about 240 programs and projects. On August 6 and 8, 2001, we briefed your staff on the results of our survey and this report summarizes those results. The briefing slides are included as enclosure I.

We conducted our work from September 2000 through July 2001 in accordance with generally accepted government auditing standards. Enclosure II describes our objectives, scope and methodology.

BACKGROUND

NASA's procedures and guidelines require that program and project managers review and apply lessons learned from the past throughout a program's or project's life cycle and to document and submit any significant lessons learned in a timely manner. NASA defines a lesson learned as "knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it is factually correct; and applicable in that it identifies a specific design, process, or decision that reduces or limits the potential for failures and mishaps, or reinforces a positive result." The failure of the Mars Polar Lander and Climate Orbiter spacecraft in 1999 raised concern that lessons learned from past mishaps and programs were not being effectively applied towards future mission success.

Lessons learned systems are used by many military, commercial and government organizations to capture, store, disseminate, and share knowledge gained from past experiences. NASA's principal mechanism for collecting and sharing lessons learned from programs, projects, and missions agency wide is the LLIS. The goal of LLIS is to ensure that NASA does not have to keep "relearning" the lessons of the past. NASA also shares lessons learned through revisions to its policies and guidance. Further, lessons learned from a mishap or operational event are captured in procedure and process documents.

SURVEY RESULTS

Our survey highlighted fundamental weaknesses in the collection and sharing of lessons learned in NASA by program and project managers as well as in the agency's LLIS. While some lessons learning does take place, our survey identified that lessons are not routinely identified, collected, or shared by program and project managers. In addition, many respondents indicated that they are dissatisfied with NASA's lessons learned processes and systems. Respondents also identified challenges or barriers to the sharing of lessons learned as well as areas of improvement. Specifically, respondents indicated the following.

- **Limited Sharing of Lessons Learned Agency-wide**

Lessons learned are of little value unless they are collected and shared with others. To determine the extent that lessons are being collected and shared within NASA, we asked program and project managers how knowledgeable they were of lessons generated by their own programs and centers as well as by other centers. Program and project managers responded that they are very or generally knowledgeable of lessons generated by their own programs and centers but are not very knowledgeable of lessons generated by programs at other centers. This fact is supported by survey results that show managers primarily identify lessons through program or center-based activities such as project reviews or informal discussions with colleagues. LLIS was not identified as a primary source for lessons learning.

- **LLIS Is Not a Primary Mechanism for Collecting and Sharing Lessons Learned**

Our survey identified several reasons why LLIS is not the primary mechanism used by program and project managers for collecting and sharing of lessons. One reason is a lack of awareness about the system. About one-third of program and project managers responded that they first learned of LLIS from our questionnaire or only became aware of the system within the last 6 months. This level of awareness also corresponds with survey results that show limited use of LLIS by program and project managers within the last 2 years.

- **Dissatisfaction with Lessons Learned Processes and Systems**

Our survey also determined that more managers are very or generally dissatisfied with NASA's lessons learned processes and systems, including LLIS, than are satisfied. This level of dissatisfaction may stem from the fact that 58 percent of managers stated that current processes and systems do not allow them to retrieve the right lessons at the right time. Another contributing factor to this level of dissatisfaction could be because program and project managers do not find existing lessons helpful: 53 percent of managers said they found lessons learned useful less than 25 percent of the time.

- **Barriers Exist to Lessons Learning**

If lessons learning is to succeed it is important that an organizational culture exist that fosters the value of sharing knowledge based on others' experiences. Our survey determined that many managers do not believe that implementing lessons learned significantly improves mission effectiveness. One manager stated that "Until we can adopt a culture that admits frankly to what really worked and didn't work, I find many of these tools to be suspect."

Another critical barrier highlighted by the survey is the lack of time available for lessons learned. One manager noted that "It is time consuming to agree on correct lessons learned for a project, accurately describe the issue...in a way that is helpful to a project." Finally, many managers noted in their narrative responses that there is reluctance to share negative lessons for fear that they might not be deemed to be good project managers. According to some respondents this appears to stem from a culture that sees lessons learned as negative, i.e., an admission of failure.

- **Suggested Improvements to Lessons Learning**

While program and project managers identified a number of ways for improving lessons learning within NASA, mentoring was their first choice. One manager noted that the most effective lessons learned process results from the passing down of lessons from experienced people to those less experienced. Other suggestions for improvement included "storytelling" or "post mortems." A manager stated that story telling would be a quick way to get the message distributed and allow persons to ask questions. Another notable suggestion was that senior management be accountable

for the infusion or engineering of lessons into a project with some kind of a matrix/metric to validate that the lessons was actually incorporated.

Managers also suggested a number of improvements regarding LLIS. Suggested improvements included (1) inclusion of more positive lessons learned, (2) an improved search capability, (3) addition of a frequently asked question section, and (4) addition of information to allow one to determine whether a lesson is applicable to a specific project. Another suggestion was that lessons be distributed once a month and an alert used to notify managers about important lessons.

AGENCY COMMENTS

NASA generally agreed with our draft report. Our efforts to assess the effectiveness of the NASA's lessons learning processes and procedures is continuing and we plan to issue a final report on the results of our work early in the next calendar year. NASA's comments in their entirety appear in enclosure III.

We are sending copies of this letter to the NASA Administrator and interested congressional committees. The letter is also available on GAO's home page at <http://www.gao.gov>. If you or your staff have any questions regarding the briefing or this letter, please contact me at (202) 512-4841, or John Oppenheim, Assistant Director at (202) 512-3111. Key contributors to this assignment were James A. Elgas, Carl M. Ramirez, Jose A. Ramos, Lorene S. Sarne, and Diana Dinkelacker.

Sincerely yours,

A handwritten signature in black ink that reads "Allen Li". The signature is written in a cursive style with a large initial "A" and a distinct "Li" at the end.

Allen Li
Director
Acquisition and Sourcing Management

Enclosures - 3

Slides from the Briefing on the Results
of NASA's Lessons Learned Survey



NASA Lessons Learned Survey Results

**Briefing to the
House Science
Committee, Subcommittee
on Space and Aeronautics**

August 6, 2001




Purpose of Survey

- Obtain views of National Aeronautics and Space Administration (NASA) program and project managers regarding:
 - Collection, sharing, and application of lessons learned
 - Strengths and limitations of NASA's lessons learned processes, procedures, and systems, including NASA's Lessons Learned Information System (LLIS)
 - Challenges or barriers to the sharing of lessons learned
 - Suggested areas of improvement

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Survey Scope

- Conducted an online survey of 192 program/project managers in June/July 2001
- Covered all Enterprise areas:
 - Earth Science
 - Human Exploration and Development of Space
 - Aerospace Technology
 - Space Science
 - Biological & Physical Research
- Identified 244 programs and/or projects

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Survey Instrument Development

- Obtained relevant information from interviews with agency officials involved in program and project management
- Reviewed lessons learned related documents and guidance
- Analyzed literature on lessons learned and knowledge management

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Survey Methodology

- NASA Headquarters and others reviewed and commented on the proposed contents of the questions
- Conducted a pretest of the survey questions with program and project managers at Goddard Space Flight Center to gauge clarity, and length of time of survey administration
- Names/addresses of NASA program and project managers were provided by NASA at our request
- We believe that our survey results are generalizable to the population of NASA program and project managers
- Practical difficulties of conducting any survey, however, may introduce errors into estimates made from surveys

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NASA's Definition of Lessons Learned

“Knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. A lesson must be significant in that it has real or assumed impact on operations; valid in that it is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or limits the potential for failures and mishaps, or reinforces a positive result.”

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NASA Processes, Procedures, and Systems for Lessons Learning

- NASA's Program and Project Management Processes and Requirements (NPG 7120.5A) states that program and project managers:
 - should review and apply lessons learned from the past throughout the program/project life cycle, where appropriate
 - shall document and submit any significant lessons learned in a timely manner
- NASA's Procedures and Guidelines for mishap investigating (NPG 8621.1) requires the identification and submission of lessons learned

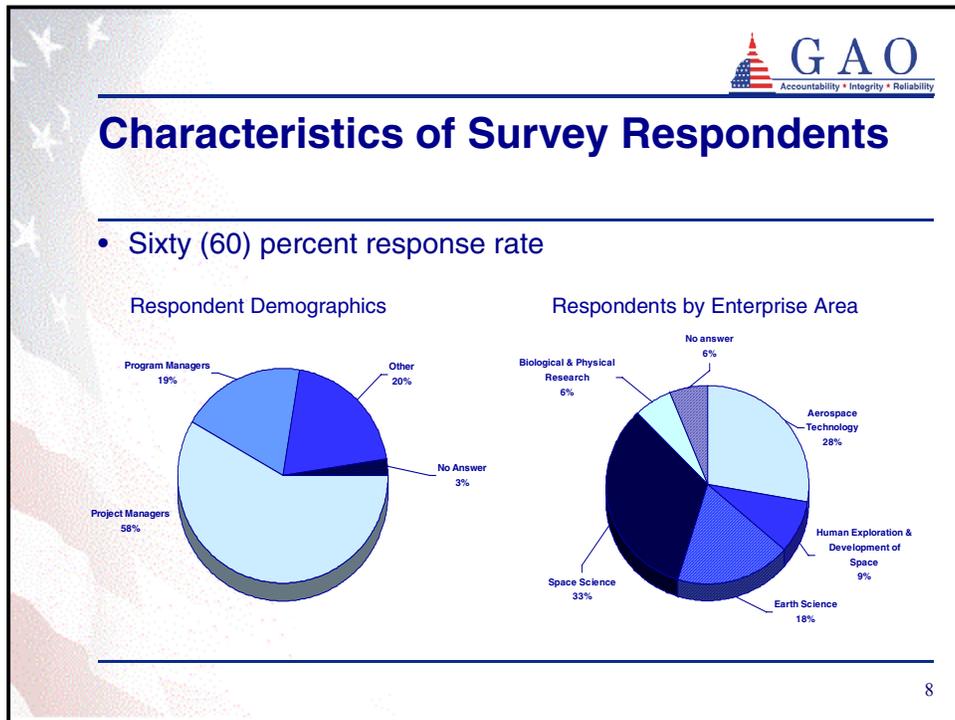
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NASA Has Established Processes, Procedures, and Systems for Lessons Learning

- NASA's Lessons Learned Information System (LLIS) is an on-line, automated data base system, was established to facilitate the capture and sharing of lessons learned agency-wide
- NASA disseminates lessons through periodic updates to policies and guidance
- Lessons learned through mishaps or other operational events are incorporated into procedure and process documents

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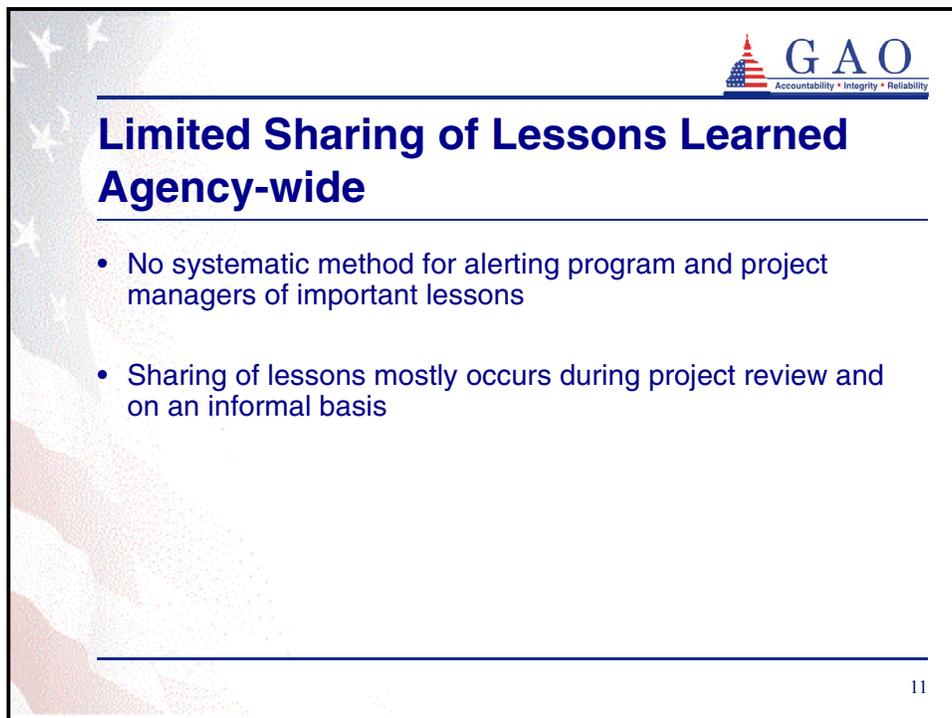
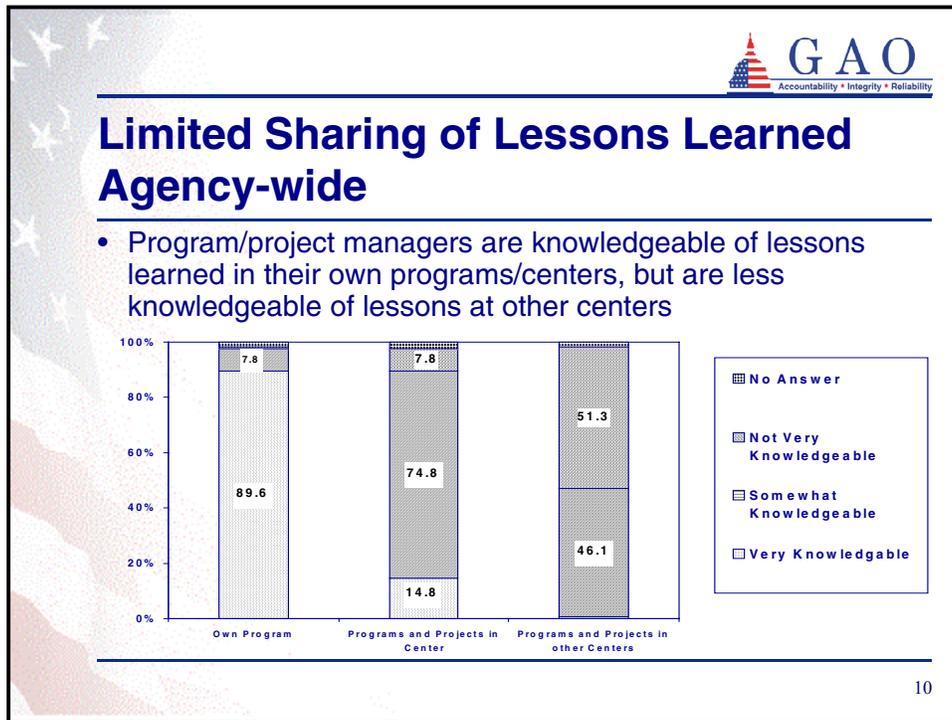


Summary of Survey Results

The survey identified fundamental weaknesses and improvements in the collection and sharing of lessons learned:

- Limited sharing of lessons learned agency-wide
- LLIS is not the primary mechanism for collecting and sharing lessons learned
- There are barriers to lessons learning
- Dissatisfaction with lessons learned processes and procedures
- Suggested improvements to strengthen lessons learned processes and procedures

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LLIS is Not the Primary Mechanism for Collecting and Sharing Lessons Learned

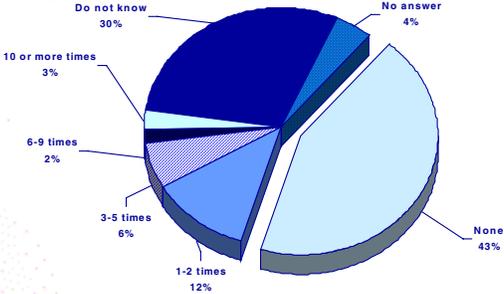
- Principal sources for identifying lessons learned:
 - 1st Source: Systems and Engineering Reviews
 - 2nd Source: Program/Project Briefings
 - 3rd Source: Informal Discussions with Colleagues
- Twenty-seven (27) percent of program and project managers were not aware of LLIS before the survey
- Only 17.5 percent of the respondents have applied a lessons learned identified through LLIS
- In the past 2 years only 23 percent of program and project managers have submitted a lessons learned to LLIS

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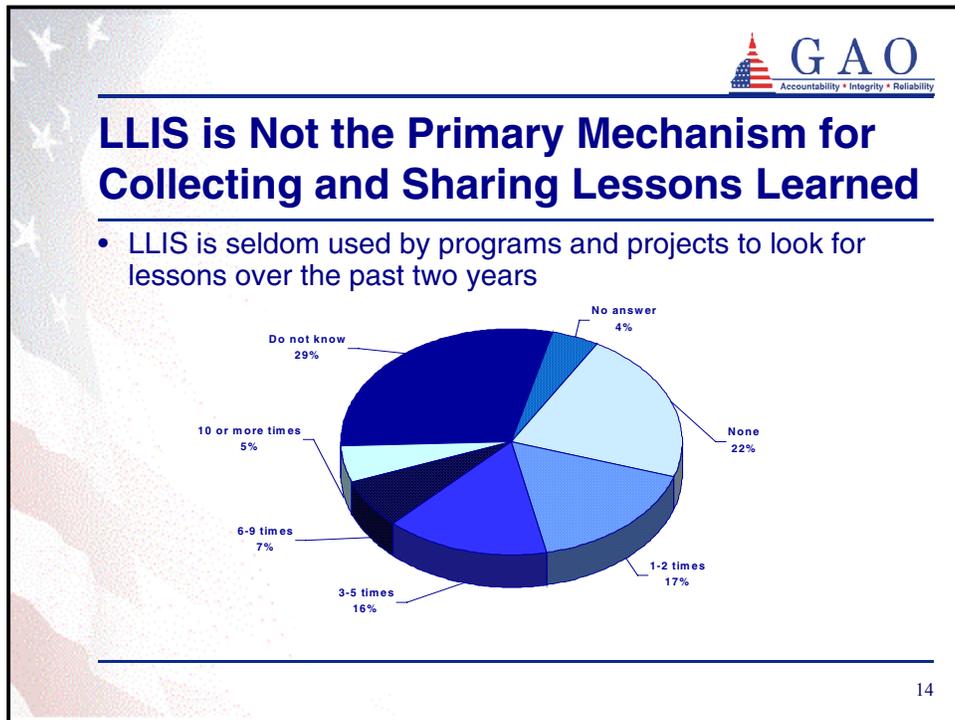
LLIS is Not the Primary Mechanism for Collecting and Sharing Lessons Learned

- In the last two years 43 percent of program and project managers have not submitted a lesson to LLIS



Frequency	Percentage
None	43%
Do not know	30%
1-2 times	12%
3-5 times	6%
6-9 times	2%
10 or more times	3%
No answer	4%

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Barriers Exist to Lessons Learning

- Thirty-nine (39) percent of program/project managers believe that implementing lessons learned contributes only some or little to improving mission effectiveness
- Managers believe there is too little time for individuals to share lessons learned:
 “It is time consuming to agree on correct lessons learned for a project, accurately describe the issue and the lesson in a way that is helpful to a project”
- Managers are reluctant to share failures with others:
 “[There is an] unwillingness...to share information or air dirty laundry. If you made a mistake you might not be deemed to be a good project manager.”

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Dissatisfaction with Lessons Learned Processes and Systems

- More respondents are very or generally dissatisfied with NASA's processes and systems than are satisfied
- Fifty-eight (58) percent stated that processes and systems infrequently allows them to retrieve the right lessons at the right time
- Managers indicate that not enough emphasis is being placed on reporting positive or successful experiences

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Suggestions Provided by Managers to Improve Lessons Learning at NASA

- Mentoring:

“I believe ‘lessons learned’ [equals] experience. Experience is gained on the job, and much of it is passed along informally through mentoring. This means there must be a base of experienced people who must be allowed to mentor the newer employees!”
- Expanded practice of “storytelling” or “post mortems”

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Suggestions Provided by Managers to Improve Lessons Learning at NASA

- Develop a capability to disseminate or notify users about important lessons learned:

“Centers should transmit public (Center-wide) emails containing important or prominent lessons learned on a regular basis”

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Suggestions Provided by Managers to Improve Lessons Learning at NASA

- Better integration of lessons learned into program/project planning and implementation procedures
- Allow more time for the lessons learned process:

“If it [lessons learned] is important then make it important. Give it the processes, procedures, resources, and particularly [the] time, to make it a positive experience. However, merely making it another requirement to an already overwhelming work schedule will doom it to the failure it presently may be experiencing”

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Recognition of the Importance of Lessons Learned

"I am encouraged by the focus and attention the lessons learned process is getting. I really hope that the follow-through is sustained...rhetoric is cheap and gets the 'motherhood and apple pie' salute. The real action of process development and improvement [is done] by actually engineering the lessons into the processes...[but this] is costly and hard. A lot of the work is about culture change to accept a new model that contrasts to 'the way we've always done it.'"

Project Manager

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Survey Objectives, Scope and Methodology

To obtain the views of NASA program and project managers on lessons learned processes and systems at NASA we conducted a survey in June and July 2001, using a self-administered electronic questionnaire posted on the World Wide Web. The survey contained four groups of questions on (1) how NASA personnel collect, access and use lessons learned; (2) the strengths and weaknesses of current NASA lessons learned processes, procedures and systems, including the Lessons Learned Information System; (3) potential challenges or barriers to sharing Lessons Learned within NASA; and (4) ways to improve the lessons learned process or system at NASA.

In designing the questionnaire, we interviewed NASA officials, program and project managers, as well as other government and industry officials who had insight into lessons learned processes and systems. We also obtained and reviewed NASA documents and guidance pertinent to lessons learned. To further guide the development of appropriate questions, we reviewed current literature on lessons learned and knowledge management. To validate the content and structure of the questionnaire, we submitted it to officials at NASA Headquarters and others for review and incorporated their comments where appropriate. To verify the clarity, length of time of administration, and suitability of the questions, we also pretested the questionnaire with selected program and project managers at Goddard Space Flight Center.

NASA officials provided us with a list of the e-mail addresses of 199 personnel that they indicated were representative of all NASA program and project managers as of April 2001. On June 5, 2001, we sent e-mail messages to each person in this survey population notifying them of the survey and asking them to complete the questionnaire. Subsequently, we discovered one additional NASA manager who was eligible for our survey, and removed 7 managers who were ineligible for the survey because they were not project or program managers at the time of the survey. We also eliminated one duplicate listing, resulting in a final survey population of 192.

Over the following several weeks until closing the survey on July 13, 2001, we received a total of 115 useable responses, for an overall response rate of 60 percent. All of the responses had been submitted using the web questionnaire, although one participant had asked to submit a paper version of the survey, due to problems in accessing the web survey. Of the 77 non-respondents, 9 provided partial questionnaire responses but had not indicated that they were finished with the questionnaire.

While we believe that our survey results are generalizable to the population of NASA program and project managers as described above, the practical difficulties of conducting any survey may introduce errors into estimates made from surveys.

Although we administered questionnaires to all known members of the population, and thus our results are not subject to sampling error, nonresponse to the entire survey or individual questions can introduce a similar type of variability or bias into our results to the extent that those not responding differ from those who do respond in how they would have answered our survey questions. In addition, population coverage errors can occur if some members of the population are excluded from the survey. Measurement errors can arise from how questions are interpreted by respondents and mistakes made by respondents. Data processing errors can arise during the handling or analysis of responses. We took steps in the design, data collection and analysis phases of our survey to minimize such errors, such as pretesting questionnaires before the survey, following up with those not reachable at original e-mail addresses or otherwise not immediately responding, and checking for errors in computer programming used to analyze survey results. In addition, the distribution of respondents across NASA Enterprise areas generally reflected the actual distribution of the entire population, which was consistent with our belief that nonresponse error was not significant.

Comments From the National Aeronautics
and Space Administration

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001



Mr. Allen Li
Director
Acquisition and Sourcing Management
U. S. General Accounting Office
Washington, DC 20548

AUG 29 2001

Dear Mr. Li:

We appreciate the opportunity to review and provide comments to the draft report, entitled, Survey of NASA's Lessons Learned Process. We have reviewed the report in detail and are essentially in agreement with the survey results and suggested improvements.

We continue to evaluate NASA processes and will do the same for lessons learned. Major revisions to NASA Procedures and Guidelines (NPG) 7120.5, NASA Program and Project Management Processes and Requirements, are in the final stages and include more clarity in the use and scope of the Lessons Learned Information System (LLIS). Since NASA uses numerous sources for lessons learned, LLIS will no longer be referred to as the primary source, but one of many.

Programs and projects benefit from lessons learned day-to-day in many different forms. Some of these include status reporting, programmatic and technical reviews, and functional staff meetings. The more formal and widespread forms include technical standards and updating NPG's and other documentation. The various NASA training programs also incorporate lessons learned into their curricula, including storytelling by current and retired NASA program and project managers. One forum is designed specifically for sharing lessons learned and is titled Project Management Shared Experiences Program. The overall objective of this program is to provide a forum to understand key initiatives influencing NASA project management and for project people to share knowledge, experiences, and creative approaches to project management.

NASA must do a better job of communicating the various lessons learned sources, improving mechanisms by which these various sources are linked, and encouraging the proper training for employees in order to maximize the ability of current activities to draw upon the lessons of others. We plan continued improvement in these areas. Should you have any questions, please call Keith Hudkins, Deputy Chief Engineer, at 202-358-1823.

Sincerely,

A handwritten signature in black ink that reads "Daniel R. Mulville".

Daniel R. Mulville
Associate Deputy Administrator

(707565)